SWINE FARM SIMULATION: AN EFFECTIVE EXTENSION MODEL

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ABSTRACT

"Swine Farm Simulation: An Effective Extension Model" by Dr. Allan E. Lines, The Ohio State University, March 1979.

The paper presents a unique model that simulates present, selected, and near-optional growth and organization strategies for the swine farm over a five-year planning horizon. Decisions made by the user on the model include product, size, growth, management system, scheduling, and building type.

SWINE FARM SIMULATION: AN EFFECTIVE EXTENSION MODEL

by

Allan E. Lines*

Introduction

Swine producers have experienced the introduction of technologies that have created new opportunities for profit and have resulted in a complex set of alternative organizational and growth strategies. Each producer faces the seemingly insurmountable task of identifying a set of feasible strategies and selecting one that will help realize the quest for maximum returns. It was for this purpose that this simulation model was developed.

Model Development

It is important to recognize the people responsible for and the process that resulted in this model. The people can be broadly categorized as initiators, developers, and implementors. Ludwig Eisgruber and John Kadlec[1/] are responsible for initiating the research and extension programs that brought this model to fruition. George Lee, Bernard Sonntag[2/], and the author successively guided the model through its developmental stages--conceptual, empirical, and extension. Very few model builders have seen their creations effectively implemented in the real world. Such is not the case with this model. David Bache[3/], John

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Kadlec, and the author developed an education program that resulted in widespread use of the model.

The first step in the developmental process was farmer recognition of the problem and their request for assistance. Secondly, the nature of the system being modelled required an inter-disciplinary approach that involved physical and economic scientists, pragmatic extension personnel, and farmers. The all-important interaction of these people began with problem and variable specification and continued throughout the process. A sound theoretical foundation tempered with practicalities of the real-world was a must for acceptance by academicians and producer-users. Minimizing this continuing interaction would have ensured an ineffective model. Thirdly, the conceptual model was built and passed the scrutiny of theoeticians, but more importantly it was understood by extension field staff and prospective users. The fourth step was to generate and validate the empirical model. Interaction and communication were paramount to success. Making sure that theoretical constructs were not violated while insuring a reasonable representation of the real-world was a monumental task. Experimentally testing the model with hypothetical data generated the much needed confidence of agents and farmers that was typified by the paraphrased comment--"When are you going to have this ready to use? We could use it now." The model was not ready to withstand the rigor of extension application at this point. Additional steps were necessary to insure effective use of the model.

The fifth step was the transformation of the empirical to the extension model that producers could and would use in their decision-making. Surprisingly, the near-optimization nature of the conceptual and empirical models limited their effectiveness in extension. The model was converted to provide the opportunity to simulate selected strategies in addition to the near-optimal, and continued to be refined in light of real-world application. An input form and printout format were designed to enable the user to communicate with the model and to readily understand its results. The model was now ready for the ultimate test.

The final step was the organization of an extension program to provide an opportunity for producers to use the model and to permit the developers to experience the implementation of their efforts. The workshop was and continues to be an inter-disciplinary subject matter oriented series of meetings during which the producer can use the model. Without this kind of a workshop it is doubtful that the model would be effectively used today.

The Model

The uniqueness of this simulation model is derived from its dynamic selective and near-optimizing solution procedure. The user can simultaneously examine continuation of the present operation, investigate a selected alternative, and determine a near-optimal strategy. The model is deterministic and the objective function of the optimizing procedure is maximum net worth at the end of five years.

Figure 1 is a brief schematic of the model. The user defines a set of conditions that are used in projecting answers to four basic decisions that are either specified by the user or determined by the model. The information generated is organized in three sections. Section one consists of a table comparing the three plans at the end of five years. The second section is an annual summary for each year

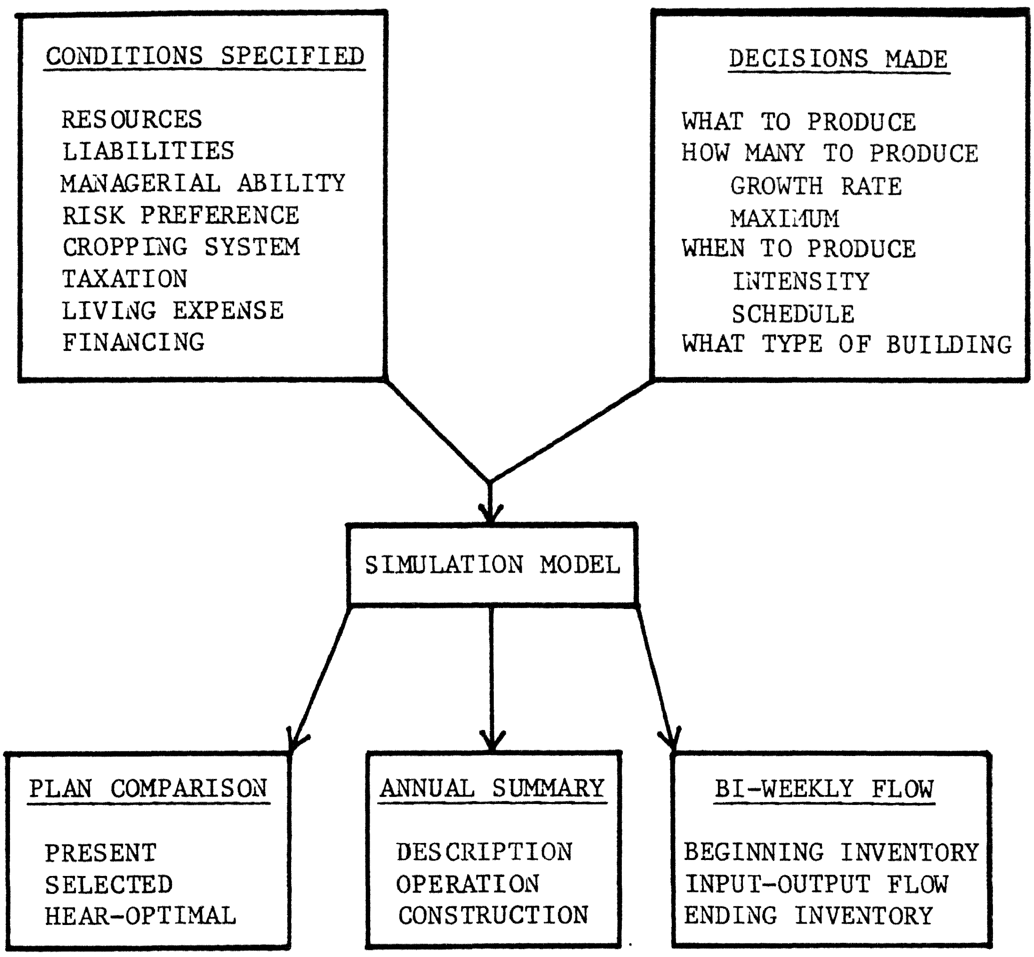

Figure 1. Schematic of Simulation Model

that includes a description of the farm, an operating statement, and a statement of construction and investment. The third section continues with detailed net worth statements and bi-weekly resources flows.

The model encompasses most of the common swine production and management activities (see Figure 2). Included are three products, eleven management systems, forty operating schedules, and three or four types of housing for each of four phases of production. Some activities are mutually exclusive and others are conditional events. For example, the three products (buy-feeders, sell-feeders, and farrow-finish) are mutually exclusive and the 2-lot system is conditional upon feeder pig purchase being in the solution vector. Crop activities (corn and soybeans) are completely predetermined if they are in the solution vector. The many possible combinations of these activities in conjunction with the opportunity to specify unique resources, technical and price coefficients, restraints, and personal preferences permits an acceptable description of most commonly used production-management systems.

Problems the Model Can Address

The model can assist producers with problems in a number of areas: (1) size and growth, (2) building selection, (3) intensity and scheduling, (4) enterprise selection, (5) cash flow projection, (6) resource needs, and (7) the impact of price, technical coefficient, and resource changes. The specific questions that can be addressed are as varied as the producers themselves, but do, however, fall into two categories--"What if---" and "What should---". Some representative questions might be:

1. What if I add sixty sows?
2. What if I farrow eight times a year?
3. What if prices are lower?
4. Should I finish my hogs?
5. What types of buildings should I construct?
6. How many sows should I farrow?

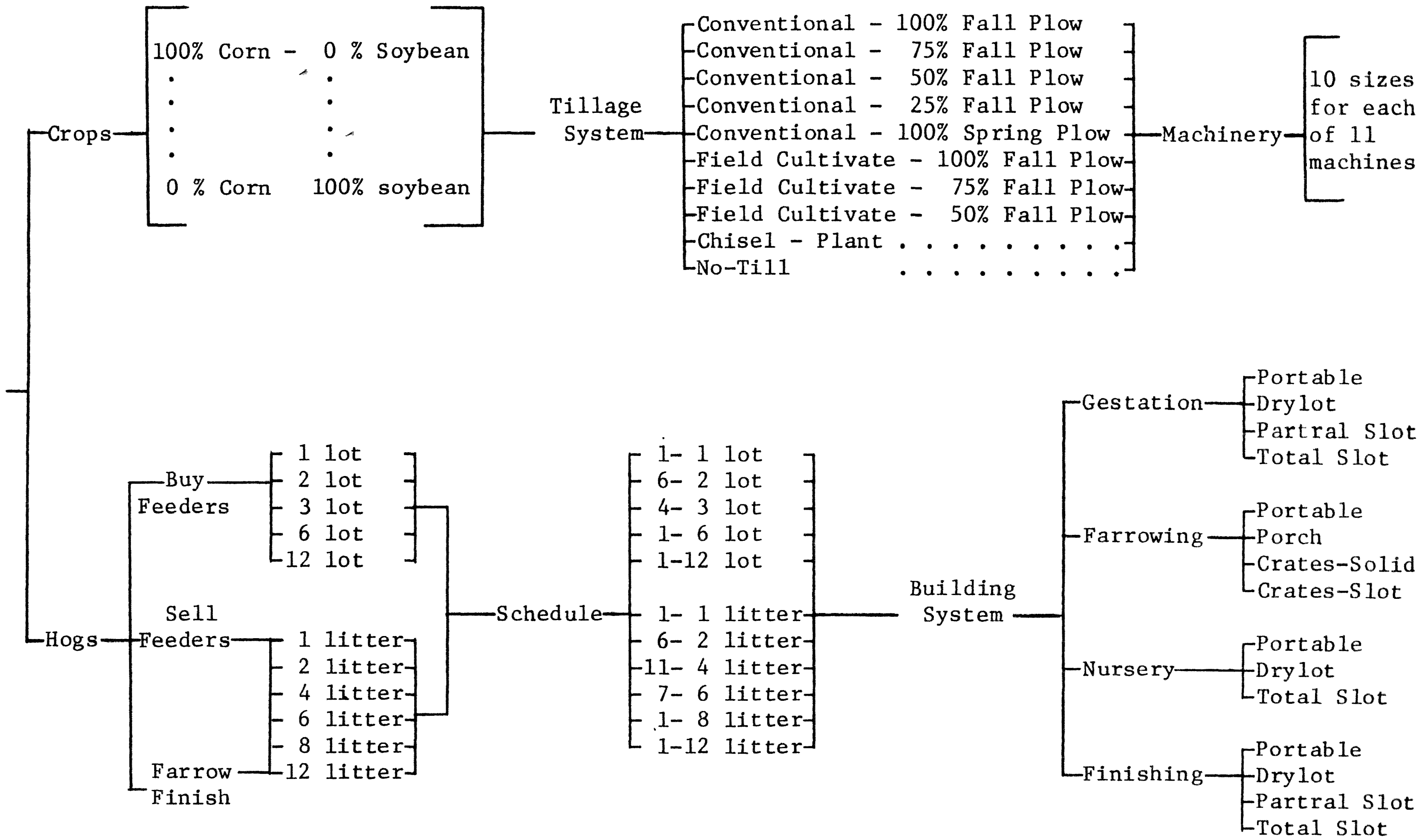

Figure 2. Simulation Model — Activities and Decision-Tree

Modes of Operation

The model has two modes of operation--budgeting and optimizing. In budgeting mode the farmer makes all the decisions as the "What if---" questions are analyzed. In optimizing mode the model can make any or all the decisions as "What should---" questions are analyzed in determining a "near-optimal" plan.

Restrictions

User specified restrictions are only operative in the optimizing mode. Four types of restraints (see Figure 3) identify the production frontier, any one of which may alter the near-optimal plan. The size, growth, and capital restraints (except short-term debt) are maximum allowable conditions are year-end. Labor and short-term debt restraints operate bi-weekly. The production frontier is redefined annually, as assets and liabilities accumulate or decummulate and as the maximum allowable size is adjusted, resulting in an expanding, contracting, or stationary frontier.

- Maximum Size
  - Sows
  - Feeders
- Growth
  - Sows Added
  - Feeders Added
- Capital
  - Debt/Asset Ratio
  - Total Debt
  - Long Term Debt
  - Intermediate Debt
  - Short Term Debt
- Labor

Figure 3. Simulation Model Restrictions

Solution Procedure

A schematic of the solution procedure is presented in Figure 5. There are four major loops in the solution procedure: (1) plan, (2) production activity, (3) size, and (4) resource determination and acquisition. Figure 4 illustrates tne extend process used in the size loop when the optimizer is activated.

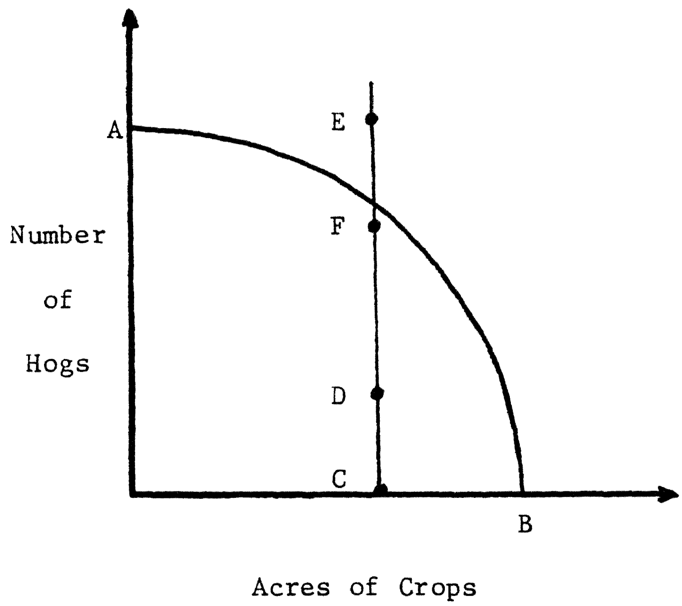

Figure 4. Simulation Model - Extend Process

Line AB represents the production frontier defined by restraints. C is the pre-determined size of crop enterprises. D represents the initial size of the swine enterprise. The model, at D, finds that restrictions are not exceeded and incrementally increases the size of the swine enterprise to E where constraints are exceeded. The process is then reversed using smaller decrements until F is identified as the first point within the production frontier.

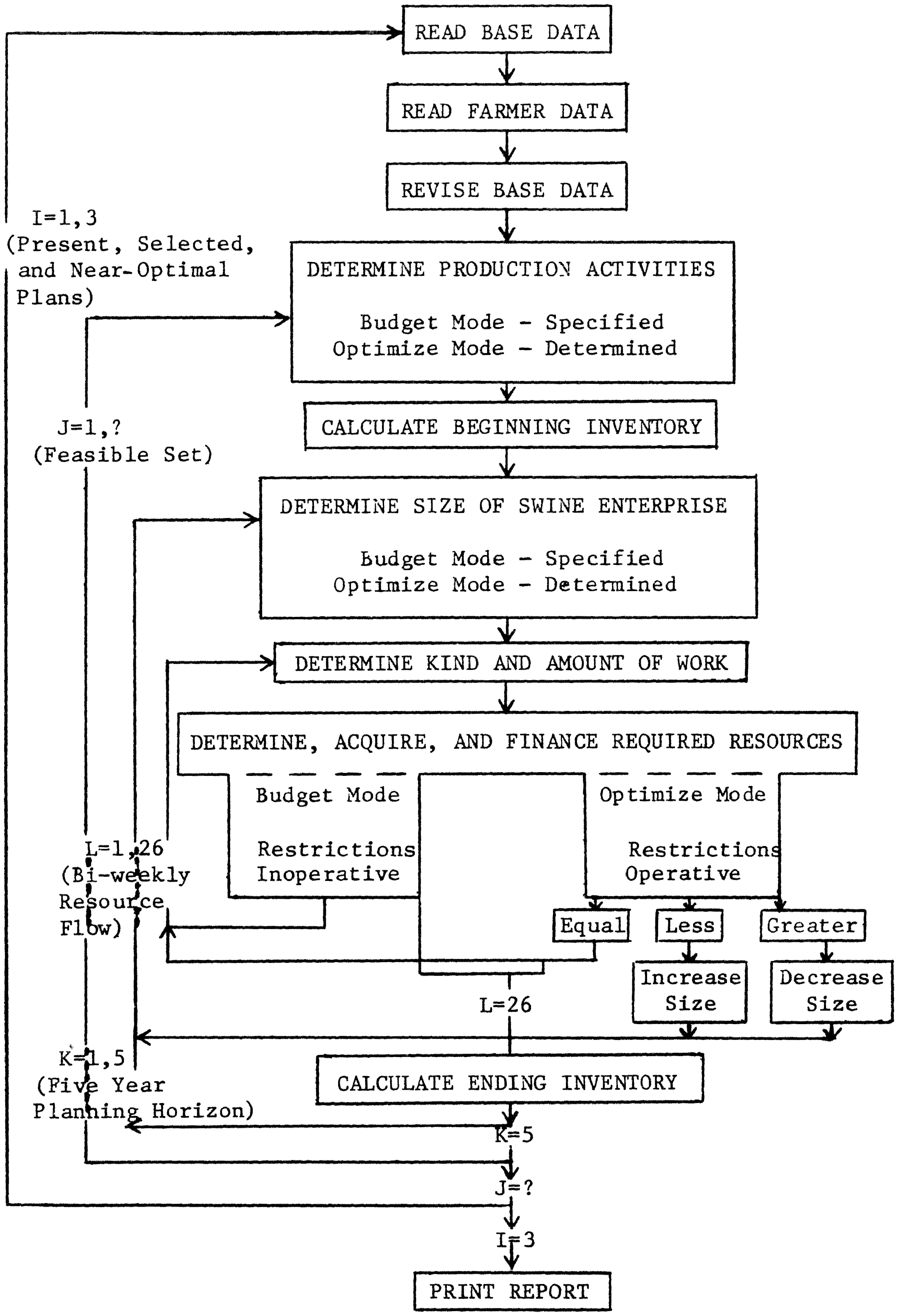

Figure 5. Simulation Model - Solution Procedure

An Application

A brief explanation of one of the many real-life uses of the model will demonstrate its characteristics and usefulness. This family wanted to investigate the economic feasibility of replacing their existing farrowing and nursery facilities and adding sixty sows.

Table 1. Comparison of Plans-End of Five Years

Item	Present Plan	Replace Bldgs. Add 60 Sows	Computer Plan
Acres	700	700	700
Sows	90	150	168
Hogs Sold	1,354	2,412	2,715
Management System	6 litter	6 litter	12 litter
Net Worth	$1,775,000	$1,770,000	$1,806,000
Percent Debt	8	12	11
New Loans	$1,000	$102,000	$62,000
Type of Buildings	None	Slotted	Partial Slot
Growth Restriction	--	--	Labor

From this analysis the family was able to see that their plans would likely result in a lower net worth and require approximately $102,000 new debt. The computer plan indicated that buildings could be replaced, size increased, fewer dollars borrowed, and net worth would increase if the management system and type of construction were changed. Based on these projections the family proceeded to replace buildings and expand production utilizing a more intensive management system and a less capital intensive type of construction than originally planned. The model provided additional information that resulted in the family implementing a strategy that would, in all likelihood, result in economic gain rather than loss. This is one of approximately four hundred situations in eight states where this model has been used effectively, with a significant impact on decisions being made in most cases.

FOOTNOTES

1/ Ludwig Eisgruber was and John Kadlec is Professor Farm Management, Department of Agricultural Economics, Purdue University.

2/ George Lee and Bernard Sanntag were graduate students in Farm Management, Department of Agricultural Economics, Purdue University.

3/ David Bache is Professor of Farm Management, Department of Agricultural Economics, Purdue University.

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